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Aggregate dredging impacts in South East England: Improving ecological health by integrating fisher ecological knowledge with scientific research

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1. Introduction

The rapid acceleration of anthropogenic activities across the globe sees new ecological impacts of extractive industries disturb even the most pristine of the planet's marine ecosystems. The fetishisation of economic growth without limits can be described as a marine 'anthropocene' (Angus, 2016). One of these disturbances is the aggregate dredging of sand and gravel from the seabed. Internationally, between 47 and 59 billion tonnes of aggregates are mined every year (Steinberger et al., 2010). Aggregate industry is both the largest (approximately 68% to 85%) and the fastest growing extractive industry in the world, with particular consequences for seas (Krausmann et al., 2009). In Europe, there are patterns of degradation across all the regional seas, with consequences for its future biodiversity and health (EEA, 2015). The metaphor of death by a thousand cuts through aggregate extraction, destructive fishing, construction, plastic and point-source organic pollution has relevance for the EU Marine Strategy Framework Directive 2008/56/EC (MSFD). Significantly, the MSFD aimed to achieve a good environmental status (GES) in EU waters by 2020. An important point of this article is that it established a framework for community action in the field of marine environmental policy (EU, 2017). In the UK, the prioritisation of nationally significant infrastructure projects such as aggregate dredging creates new and continuous challenges for small-scale fishers who have seen a continuous decrease in traditional fishing grounds. This paper identifies the conflict in aggregate dredging reported by fishers in the South East English Channel. The sea of South East England has the busiest shipping channel in the world and sees yet more planned usage. Aggregate dredging is reported to decrease habitat (Tillin et al., 2011), causes acoustic pollution (Simpson et al., 2015) and disturbs ecosystems. The paper develops a strategy for increased socioecological health, by creating zones that exclude such impacts. The integration of fisher local ecological knowledge (LEK) with scientific research by the evolution of the Territorial Use Rights Framework (TURF) (Christy, 1982) can support ecological health. In the UK context, this would evolve with the Inshore Fisheries and Conservation Authorities (IFCAs). TURFs can complement conservation or marine protected area (MPA) strategies by limiting impacts in existing open access areas, where there is social resistance to them from fishing communities, while improving collective knowledge of ecosystems.

The following literature review indicates that previous works failed to consider fisher LEK in decision-making. This relates to how fisher LEK is perceived by the government. The perception of the need to scientifically validate LEK limits ecosystem-based management. The present paper utilises participant observation with different forms of fishing gear, focus groups, semi-structured interviews and a review of the policy literature. The results indicate the importance of considering fisher LEK in coastal space (Johnsen et al., 2014), which is significant in its capacity to draw attention to ecological risk. This article explores three cases in the English Channel: the first where fisher LEK was not validated, the second where fisher LEK was validated, and the third had spatial and strategic ramifications for an MPA. The results show that with the current system of governance, it is important to consider the integration of LEK with scientific research seriously. They also show that fisher LEK can identify ecological disturbance and improve ecological health and that supporting sustainable activities is more important than supporting those that are more profitable.

2. Literature review

2.1. The governance system and the blue growth agenda

This section assesses critical literature on the governance system and the blue growth agenda in the UK and internationally. It also reflects on small-scale fishing, aggregate dredging, conservation and their inter-relations. Further, it provides an overview of opportunities for a more democratic system to evolve, which are explored further in the discussion section. A system is developed where local knowledge of environmental risk can be supported by governmental socio-ecologists under an ecosystem approach. Blue growth is defined by the EU as a long-term strategy to support sustainable growth in marine and maritime sectors (EU, 2018).

Contemporarily, the prioritisation of blue growth indicates that healthy sea ecosystems are considered to have less priority by the UK government. This has led to the prioritisation of aggregate dredging and other forms of development over conservation and artisanal fishing. While Jones et al. (2016) report that marine plans appear disconnected by design in England and across the EU, others have suggested that this

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Acronyms

LEK	local ecological knowledge
MSFD	Marine Strategy Framework Directive 2008/56/EC
MCAA	Marine and Coastal Access Act 2009
MMO	Marine Management Organisation
CEFAS	Centre for Environment, Fisheries and Aquaculture Sciences
GES	Good environmental status
IROPI	Imperative Reasons for Overriding Public Interest
TURF	Territorial Use Rights Framework
IFCA	Inshore Fisheries and Conservation Authority
CFP	Common Fisheries Policy
MSP	Marine spatial planning
MPA	Marine protected area
VMS	Vessel monitoring system

designed disconnection from communities breaches 'public participation in decision-making' obligations of the Aarhus Convention (De Santo, 2016). Additionally, certain types of scientific knowledge dominate decisions, thereby leaving fisher LEK of the benthos out of the process. Fisher LEK can draw attention to ecologically damaging activities. Ultimately, a move towards an ecosystem approach is needed, i.e., one that 'considers the entire ecosystem, including humans', in this case, fishers and their understanding of impacts from aggregate dredging (Douvere 2008: 764). A successful transition to ecosystem-based management requires decisions in tune with feedback from the impact of human activities. This transition is best achieved by having multi-spatial scale institutions, thus mirroring the complexity of the ecosystems being addressed (Wilson, 2006; De Santo, 2016). The article identifies that decision-making over marine licensing is the real forum where changes can be made. Therefore, it is important to explain how the conservation legislation, the MSFD framework for community action, can be implemented and how different experimental and experiential ecological knowledge can be used.

The following literature provides the validation of knowledge and democratic decision-making in its legal and blue growth context. In the UK and EU, the economic demands under the Directive Establishing a Framework for Maritime Spatial Planning (2014/89/EU) remains in tension. In tension with the objectives for improving marine ecological health, targeted for a good environmental status (GES) by the MSFD by 2020 (Qiu and Jones, 2013). This has led to the domination of blue growth priorities. By a top-down, strategic sectoral planning, decision-making has now been disconnected from communities by design (Jones et al., 2016). Indeed, demands for growth means that there is no policy for a cut-off percentage of benthic habitat loss by development. While an appropriate assessment (under the Habitats Regulations) is triggered if activities including construction, dumping and aggregate dredging occur within 2 km of an MPA, there remains an area of 773,676 km^2 outside MPAs (JNCC, 2017). Some of these areas feature habitats worth conserving and traditional low impact, artisanal fisheries. Nevertheless, it is important to note that if developments (including the example aggregate cases discussed below) have been judged as having met the test for 'Imperative Reasons of Overriding Public Interest' (IROPI), (contained in Article 6(4) of the EU's Habitats Directive), they can adversely impact the protected ecosystem even if within an MPA (Morris and Gibson, 2007). The IROPI test identifies that if the project is significant for economic growth, then an alternative ecosystem elsewhere can be created as compensation. Nevertheless, it is difficult to recreate the same habitat under water lost by aggregate dredging.

2.2. Introducing aggregate dredging

Aggregate dredging causes extraction of sand and gravel from the seabed, thereby changing topography and sediment composition (Cooper and Barry, 2017). It occurs only where deposits are of sufficient thickness and where the water depth does not exceed 50 m (Marchal et al., 2014). It results in an average of 30–70% reduction in biodiversity and a simultaneous 40–90% loss of population from the benthos to the water column (Newell et al., 1998). Additionally, materials mobilised by dredging are transported and deposited a kilometre outside the original dredge site, the vast plume of suspended fines, thus impacting the biodiversity and abundance of the benthos in a significant way (Hitchcock et al., 2002 and Ashraf et al., 2011). Importantly, it is thought that a long-term recovery develops only when the original sediment composition has been restored (Boyd et al., 2005). In the cases below in South East England, this includes commercial fish species such as Dover Sole *Solea solea* and Plaice *Pleuronectes platessa* and edible crab species *Cancer pagurus*. Additionally, species important for biodiversity through habitat formation, including *Sabellaria spinulosa*, the biogenic worm reefs, are threatened. While Cooper and Barry (2017) note that the new 'Regional Seabed Monitoring Programme' (RSMP) is designed to identify when unacceptable

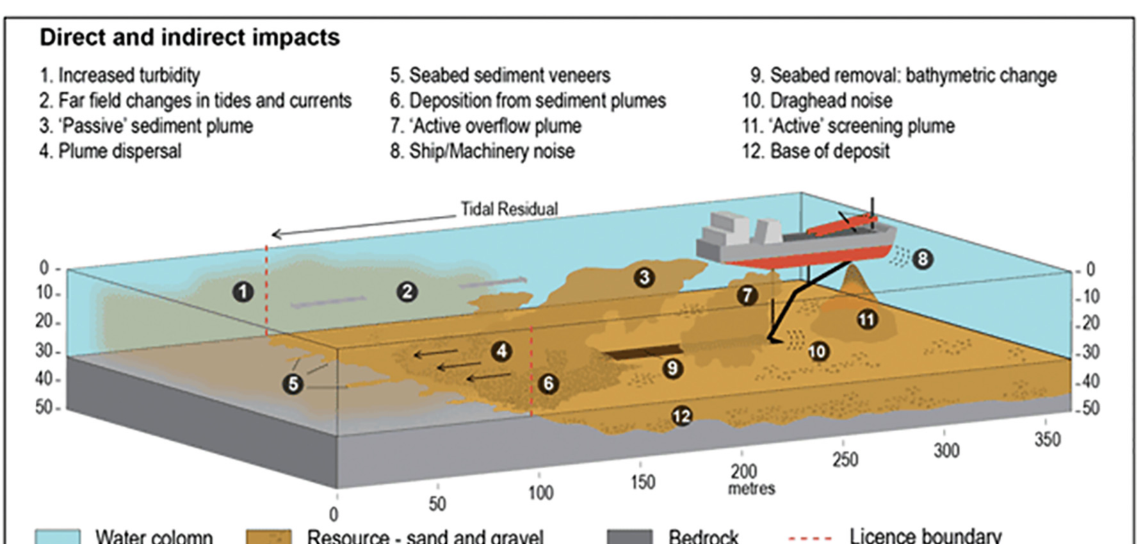

Fig. 1. Impacts of aggregate dredging from Tillin et al. (2011).